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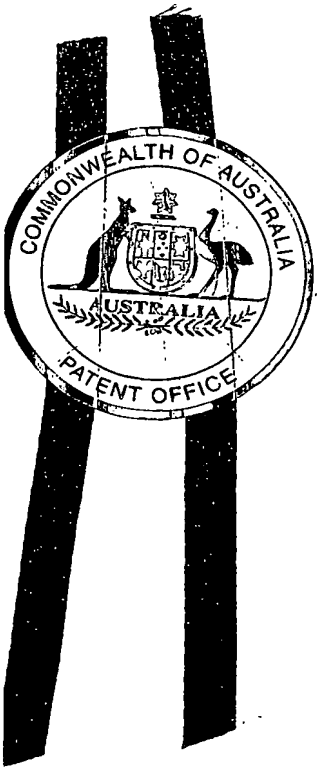

WITNESS my hand this
Fourth day of September 2003

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METHODS FOR PRE-TREATMENT OF SALINE PROCESS WATER IN GOLD MINING OPERATION

The present invention relates to novel methods for pre-treatment of saline process water for use in gold mining operation, and particularly, for efficient operation of CIL circuits used in the recovery of gold from the ore material. The invention also offers the added advantage of generating one or more chemical products of value, which products may be used by mining, mineral processing and related industries or alternatively used for mine site rehabilitation or sold as chemicals of commercial value for cost recovery and/or generation of revenue. Accordingly, one aspect of this invention relates to disclosure of alternative methods for pre-treatment of saline water for use by gold mining industry to improve the operation of CIL circuits and reduce the costs associated with excessive use of lime, and another aspect of the invention relates to generation and sale of useful chemical products for cost recovery and generation of revenue.

Because of limitations with a secure access to fresh or brackish water resource, the bulk of water used for processing of ore in CIL circuit of many gold mines in Australia and elsewhere is comprised of highly saline water of largely groundwater origin that is generated on site by mining operation or recovered by pumping from local saline aquifers. Apart from Sodium (Na) and Chloride (Cl) ions as the main ionic constituents, these saline waters are also commonly characterised by elevated concentration of Magnesium (Mg) and Sulphate (SO4) ions in dissolved form. A major problem in processing of gold-bearing ores relates to the need for highly alkaline process water to achieve satisfactory gold recovery rates from the CIL circuit. The elevated concentration of Mg ion inherent in most natural saline waters has a pH buffering effect and hence reduces the efficiency of cyanide leach process and hence the gold recovery rates. To negate the buffering effect of high Mg concentration in the feed water, conventionally, large quantities of hydrated lime is added either to grounded ore or to water-ore slurry to ensure the pH of elution water is maintained at 10 or over. However, apart from the added cost of excessive lime addition to achieve the desired pH levels, this practice also generates other significant operational problems, added costs and environmental risks, including but not limited to: (a) inefficiency of the overall process in terms of progressive decrease in gold recovery rates, (b) reaction of Calcium (Ca) ion from the added lime with SO4 in the saline feed leading to precipitation of gypsum ($CaSO_4.2H_2O$) mineral through the process as well as encrusting the circuit equipment, consequentially causing significant scaling/fouling/corrosion problems, and thus adding to the plant maintenance and downtime costs, (c) Cyanide gas breakout in plant environment by dropout of pH which is a cause of industry and community concern and negates the objectives of the International Cyanide Management Code for improved cyanide management by gold mining industry.

It is accordingly a prime object of the present invention to disclose alternative methods for pre-treatment of saline water used in processing of gold-bearing ores in order to achieve one or more of the following outcomes in a cost-effective and environmentally safe and sustainable manner:

(a) remove the bulk of dissolved Mg ion in the saline water to achieve a pH of 10 or higher for the elution water,

(b) remove gypsum formation in the feed to CIL circuit and avoid gypsum fouling in the follow up steps, and

(c) where possible, recover valuable chemical compounds from the feed pre-treatment process.

The saline feed solution used by gold mining industry, and the subject of this application, are saline or hyper-saline solutions of largely groundwater origin having total dissolved solids two or more fold higher than that of standard seawater, and characterised by elevated concentration of Mg and SO4 ions but relatively low to moderate concentration of Calcium (Ca), and Carbonate and Bicarbonate (HCO3+CO3) species.

According to the present invention there are five (5) Options for pre-treating the above-described saline water types, comprising the process steps shown in FIGURE 1 and described below:

(Pre-Treatment Option 1)

(a) reaction of the raw saline water with Na2CO3 under constant stirring conditions for a prescribed length of time to allow formation of a slurry, which slurry is then washed and dewatered to obtain a useable compound composed of MgCO3 and CaCO3 minerals;

(b) storage of the spent water in a pond or a container to allow aeration and aging of the water;

(c) reaction of the aged water with Na2CO3 to produce a slurry, which slurry is washed and then dewatered to produce a high grade product composed of MgCO3 minerals;

(d) transfer of the spend water from the MgCO3 production circuit to a reaction vessel and addition of lime slurry [Ca(OH)2] first under fast and then slow mixing conditions to form a slurry, which slurry is then washed and dewatered to produce a compound of desired thickness, comprised of Mg(OH)2 and CaCO3 minerals; and

(e) transfer of the spent water from the Mg(OH)2+CaCO3 production circuit to a storage pond or a container to allow the solution to mature by aeration, which solution can then be fed directly to the CIL circuit.

(Pre-Treatment Option 2)

(a) reaction of the raw saline water with Na2CO3 as per step "a" of the Option 1, disclosed above;

(b) reaction of the spent water with lime slurry as per step "d" of the Option 1, disclosed above; and

(c) storage and aging of the spent water, as per step "e" of the Option 1, disclosed above, which solution can then be fed directly to the CIL circuit.

(Pre-Treatment Option 3)

(a) reaction of the raw saline water with lime slurry as per step "d" of the Option 1, disclosed above; and

(b) storage and aging of the spent water, as per step "e" of the Option 1, disclosed above, which solution can then be fed directly to the CIL circuit.

(Pre-Treatment Option 4)

(a) reaction of the raw saline water with NaOH under constant stirring conditions for a prescribed length of time to allow formation of a slurry, which slurry is then washed and dewatered to obtain a useable compound composed of Mg(OH)2 minerals;

(b) transfer of the spent water from Mg(OH)2 production circuit to a storage pond or a container to allow the solution to mature by aeration, which solution can then be fed directly to the CIL circuit.

(Pre-Treatment Option 5)

(a) reaction of the raw saline water with Na2CO3 while bubbling the solution with CO2 gas, under constant stirring conditions for a prescribed length of time to allow formation of a slurry, which slurry is then washed and dewatered to obtain a useable compound composed of MgCO3 minerals, and the spent water fed directly to the CIL circuit.

The process routes disclosed herein, offer a broad range of options for the pre-treatment of various saline water streams for use by mining and mineral processing industry for effective and sustainable recovery of gold from ore material using saline feed, CIL process or similar gold recovery methods. Having considered the desired pH level of the elution water, and following the prescribed process steps in one of the disclosed pre-treatment options, significant advantages, unmatched by current practices, can be achieved. These advantages include but not limited to:

- Achievement of a pH 10 and higher for saline feed to CIL circuit, while one or more useful Magnesium ion based products are recovered.
- Improved operatability by removing gypsum and the problems associated with presence of un-reacted lime in the CIL circuit.
- Avoidance of gypsum formation throughout the process train by upfront exhaustive removal of Ca ion.
- Simplicity of the feed pre-treatment options and their adaptability to existing gold recovery processes.
- Reduced risk of cyanide release to the environment.
- Better management of saline water and waste effluent after the elution step.

- Cost efficiency due to reduced lime usage, avoidance of gypsum formation and associated scaling and fouling problems, combined with potentially significant return from the sale of chemical products.
- Improved energy utilisation and a better management of CO2 gas emission.

In summary, this invention offers five (5) simple and effective methods for the pre-treatment of saline streams, characterised by elevated concentration of Mg and SO4 ions, for their use as quality process water for cost effective and sustainable operation of gold recovery from ore material, particularly in the CIL and similar leach processes where elevated alkalinity of feed medium is essential.

Geo-Processors Pty Limited

Dated this ..... day of November 2002

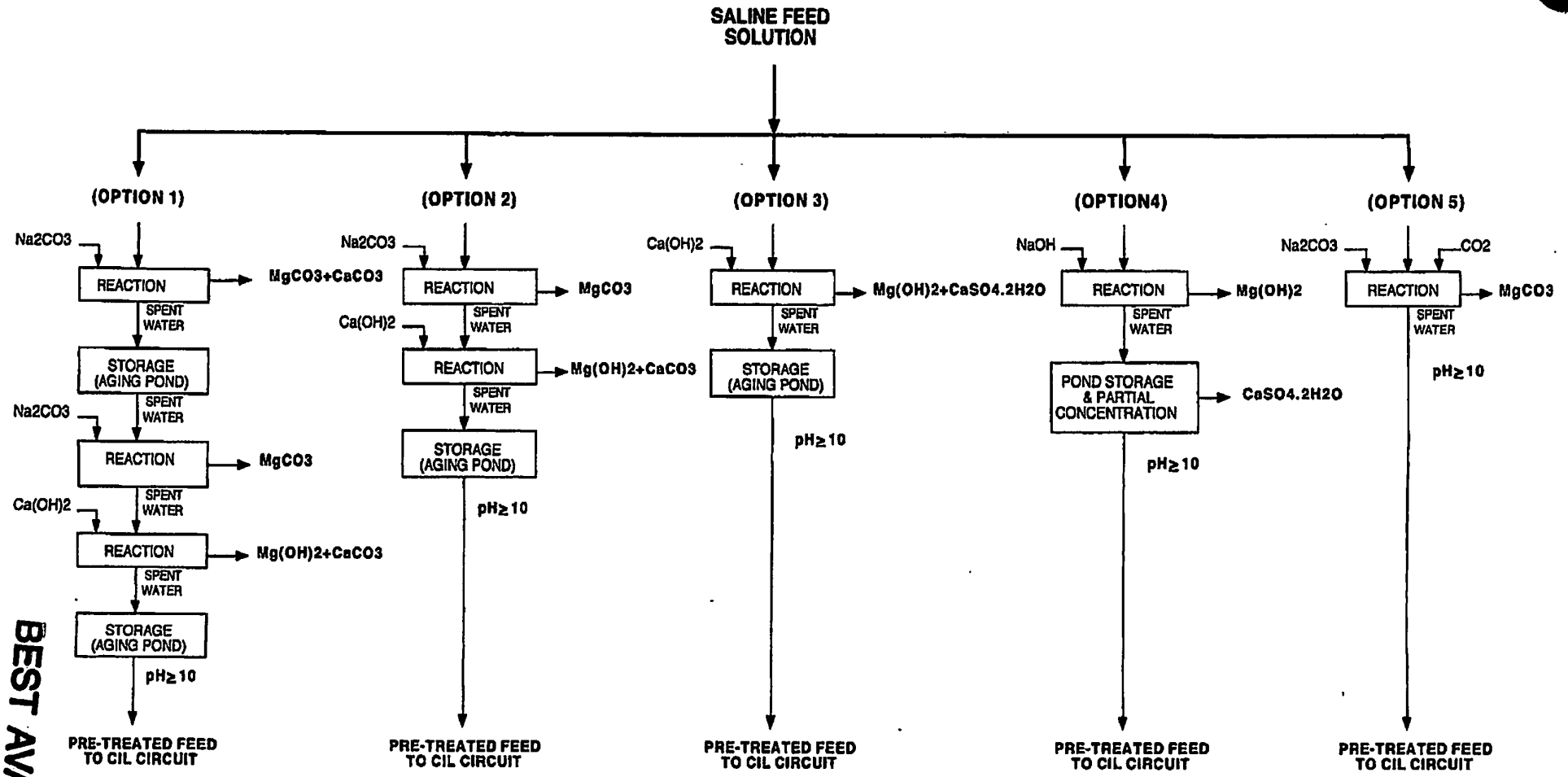

FIGURE 1

(To accompany Provisional Application by Geo-Processors Pty Limited, entitled: "METHODS FOR PRE-TREATMENT OF SALINE PROCESS WATER IN GOLD MINING OPERATION"